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AUTHORITY

AFAL ltr 17 Aug 1879

WADC TECHNICAL REPORT 52-183
SUPPLEMENT 2

ANNUAL REPORT ON RESEARCH FOR USE IN ANC-17 BULLETIN, "PLASTICS FOR AIRCRAFT"

DONALD G. COLEMAN

FOREST PRODUCTS LABORATORY

OCTOBER 1954

WRIGHT AIR DEVELOPMENT CENTER

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MATERIALS LABORATORY
CONTRACT No. AF 33(038)-51-4326E
PROJECT No. 7340
TASK No. 73400

WRIGHT AIR DEVELOPMENT CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

Carpenter Litho & Prtg. Co., Springfield, O.
400 - 7 February 1955

FOREWORD

This report was prepared by the Forest Products Laboratory under USAF Contract No. AF 33(038)-51-4326E. The contract was initiated under Project No. 7340, Rubber Plastic and Composite Materials, Task No. 73400, Structural Plastics, formerly RDO No. 614-12, Structural Plastics, and was administered under the direction of the Materials Laboratory, Directorate of Research, Wright Air Development Center, with Mr. D. H. Cartolano acting as project engineer.

ABSTRACT

Developments in the program of research in plastics for aircraft conducted by the U. S. Forest Products Laboratory during fiscal year 1954 are summarized. The approach has been in general to derive criteria mathematically and then to check by test. Two technical reports issued during the fiscal year are abstracted.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

M. R. WHITMORE
Technical Director
Materials Laboratory
Directorate of Research

TABLE OF CONTENTS

		Page
Introduction		1
Item A.	Fatigue Properties of Glass-Fabric-Base Plastic Laminates Subjected to Axial Loading	1
Item B.	Effect of Thickness on the Strength of Glass-Fabric Plastic Laminates	1
Item F.	Preparation of ANC-17 Bulletin	2
Item 54-1.	Elastic Properties and Strengths of Glass-Fabric-Base Laminates with Individual Laminations Oriented in any Direction	2
Item 54-2.	Bearing Properties of Glass-Fabric Laminates	2
Item 54-3.	Interlaminar Shear Properties of Glass-Fabric Laminates	2
Item 54-4.	Properties of Glass-Fabric Epoxy Resin Laminates	3
Reports on Research in Plastics for Aircraft Issued by U. S. Forest Products Laboratory During Fiscal Year 1954		4

INTRODUCTION

This annual report by the U. S. Forest Products Laboratory covers developments in the program of research in plastics for aircraft conducted by the Laboratory during fiscal year 1954. It is the third of such annual reports. For information on previous work under this program, see the reports of the same title for fiscal years 1952 and 1953. The 1952 report was published by the U. S. Air Force, Wright Air Development Center, as WADC Technical Report No. 52-183, and the 1953 report as Report No. 52-183, Supplement 1.

Item A. --Fatigue Properties of Glass-Fabric-Base Plastic Laminates Subjected to Axial Loading

Fatigue data are important to the proper design of aircraft structures. This project was designed to furnish data on the fatigue properties of three typical laminates and to evaluate the effects of such factors as high-humidity exposure, stress risers, and magnitude of mean stress. Dead-load tests were included in the project to furnish data on stress in tension versus time to failure on one material.

Data relating the alternating stress that could be sustained for various numbers of cycles to the mean stress imposed in test were presented in Report 1823. Lacking other data, the end points at the level of zero alternating stress were taken as the static tensile strength. More properly, the end points are the steady stresses that can be sustained for periods equivalent to a specific number of cycles. Report 1839 presents data on this point. Report 1823-A (April 1954) presents curves relating alternating and mean stresses with the end points corrected on the basis of the data of Report 1839.

This item is now complete.

Item B. --Effect of Thickness on the Strength of Glass-Fabric Plastic Laminates

Previous annual reports have summarized data on the effect of thickness of laminate on strength properties. Substantial strength reductions have been found for laminates and sandwich facings in thicknesses below about

1/16-inch. Semiempirical relations between strength and thickness have been fitted to the data. Report 1831 (May 1954) presents the results of the study.

This item is now complete.

Item F. --Preparation of ANC-17 Bulletin

A revision of the first draft of the ANC-17 Bulletin, "Plastics for Aircraft," was completed and is being reviewed.

Item 54-1. --Elastic Properties and Strengths of Glass-Fabric-Base Laminates with Individual Laminations Oriented in any Direction

A mathematical analysis giving the stress-strain relations and the strength properties of general glass-fabric-base laminates was completed. Experimental work to substantiate the analysis was started.

Item 54-2. --Bearing Properties of Glass-Fabric Laminates

Bearing properties of three typical laminates were presented in Report 1824. The current project is designed to provide bearing data on additional aircraft laminates and to determine whether or not there is a thickness effect such as was found for other properties in Item B.

Difficulties in procuring glass fabrics meeting specifications have delayed the experimental work.

Item 54-3. --Interlaminar Shear Properties of Glass-Fabric Laminates

The low interlaminar shear strength properties of polyester-glass laminates reportedly has limited some applications of these materials. Data indicate that laminates made with epoxy resins have somewhat better properties in this respect; however, data on this property are sparse. This project is designed to evaluate, at least in a preliminary way, the variation of interlaminar shear strength with resin type, with reinforcement type, and with resin content.

Preliminary tests led to the adoption of a specimen of the block-shear type similar to that described in Report 1803. Difficulties in procuring material, as with Item 54-2, have delayed the experimental work.

Item 54-4. --Properties of Glass-Fabric Epoxy Resin Laminates

Data available for inclusion in the ANC-17 Bulletin were principally on polyester laminates. To provide some data on epoxide laminates, tensile, flexural, compressive, and bearing tests were made on laminates fabricated with two epoxide resins. Tensile, compressive, and flexural data were furnished to WADC for review.

REPORTS ON RESEARCH IN PLASTICS FOR AIRCRAFT ISSUED BY U. S. FOREST PRODUCTS LABORATORY DURING FISCAL YEAR 1954

FPL Report Number	Title
1831	Effect of Thickness on Strength of Glass-Fabric-Base Plastic Laminates. 1954.

The unit strength of glass-reinforced laminates decreases with decreases in thickness. Equations are given for the tensile, compressive, and flexural strength values.

1823-A	Supplement to Fatigue Tests of Glass-Fabric-Base Laminates Subjected to Axial Loading. 1954.

Shows the relation between the duration of alternating stresses at various mean stress levels as obtained in axial-loaded fatigue tests and the duration of steady stresses at various stress levels as obtained in axial-loaded stress-rupture tests.